

*FUNCTIONAL ANALYSIS OF INAPPROPRIATE
MEALTIME BEHAVIORS*

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The purpose of the current investigation was to apply the functional analysis described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) to the inappropriate mealtime behaviors of 15 children who had been referred to an intensive program for the assessment and treatment of severe feeding disorders. During Study 1, we conducted descriptive assessments of children and parents during meals. The results of Study 1 showed that parents used the following consequences for inappropriate mealtime behaviors: coaxing and reprimanding, allowing the child to periodically take a break from or avoid eating, and giving the child preferred food or toys following inappropriate behavior. The effects of these consequences were tested systematically in Study 2 when we conducted analogue functional analyses with the children. During alternating meals, one of the consequences typically used by parents consistently followed inappropriate child behavior. Results indicated that these consequences actually worsened behavior for 10 of the 15 children (67%). These results suggested that the analogue functional analysis described by Iwata et al. may be useful in identifying the environmental events that play a role in feeding disorders.

DESCRIPTORS: descriptive assessment, feeding disorders, functional analysis, negative reinforcement

A feeding disorder is identified when a child is unable or refuses to eat or drink suf-

ficient quantities to maintain nutritional status, regardless of etiology (e.g., Babbitt, Hoch, & Coe, 1994; Budd et al., 1992). The complications from feeding problems range from mild (e.g., missed meals) to severe (e.g., malnourishment, lack of growth, or failure to thrive; Polan et al., 1991). Despite the potential seriousness of the problem, little is known about the etiology of

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feeding problems or factors that maintain feeding problems. Rather, the vast majority of research on feeding problems has focused on treatments to increase acceptance and decrease problematic mealtime behavior (e.g., Ahearn, Kerwin, Eicher, Shantz, & Swearingin, 1996; Cooper et al., 1999; Hoch, Babbitt, Coe, Krell, & Hackbert, 1994; Kelley, Piazza, Fisher, & Oberdorff, 2003; Patel, Piazza, Kelly, Ochsner, & Santana, 2001; Patel, Piazza, Martinez, Volkert, & Santana, 2002; Patel, Piazza, Santana, & Volkert, 2002; Piazza et al., in press; Riordan, Iwata, Finney, Wohl, & Stanley, 1984; Riordan, Iwata, Wohl, & Finney, 1980). These studies have shown that treatments based on operant consequences (e.g., escape extinction) are effective for increasing consumption in children with feeding problems (Ahearn et al.; Cooper et al.; Hoch et al.; Patel et al., in press).

Based on the success of operant consequences in the treatment of feeding problems, a number of investigators (Ahearn et al., 1996; Cooper et al., 1999; Hoch et al., 1994) have hypothesized that feeding problems are, at least in part, learned behaviors that develop as a result of a child's interactions with the environment (e.g., through negative reinforcement, such as escape from eating, or through positive reinforcement, such as attention or access to tangible items). Nevertheless, relatively little research on the role of environmental events on the maintenance of feeding problems has been reported. Understanding the functional characteristics (i.e., reinforcing effects of environmental events) of feeding problems may be helpful in developing treatments that more precisely match the sources of reinforcement that maintain the problem.

Experimental functional analyses have been used to quantify precisely the reinforcing functions of destructive behavior such as self-injury. For example, Iwata, Dorsey, Sliker, Bauman, and Richman (1982/1994) ex-

posed individuals to a series of conditions in which antecedent events and reinforcing consequences for self-injurious behavior (SIB) were manipulated. The results suggested that experimental functional analysis was useful in identifying the environmental contexts in which SIB was likely and unlikely to occur. Functional analysis was originally developed to assess environmental variables that influence SIB; however, this method has been used subsequently with a wide array of behavior problems, including aggression (Thompson, Fisher, Piazza, & Kuhn, 1998), elopement (Piazza et al., 1997), pica (Piazza, Hanley, & Fisher, 1996), psychotic speech (Fisher, Piazza, & Page, 1989; Mace & Lalli, 1991), and tantrums (Vollmer, Northup, Ringdahl, LeBlanc, & Chauvin, 1996).

Even though functional analysis has been applied to a wide array of behavior problems, it has been used infrequently in the assessment of feeding problems. The rationale for applying functional analysis to the assessment of feeding disorders is that regardless of the original etiology of a feeding disorder, parents use a variety of consequences to motivate their children to eat. For example, children may display food refusal behaviors such as crying, head turning, and batting at the spoon. Faced with this exhibition, parents may terminate the meal and wait for the child to "calm down" before continuing. Parents also may provide increased attention following problematic mealtime behavior. For example, a parent may coax the child to eat (e.g., "you like this, it's good for you") or alter the quantity or quality of attention (e.g., play games with the child such as "here comes the airplane") following food refusal. Some parents may provide the child with a more preferred food (e.g., peanut butter and jelly sandwich) when the child refuses a less preferred food (e.g., brussel sprouts) so that the child eats something rather than nothing. Parents also

may provide toys during the meal to calm or distract the child. From a parental perspective, consequences such as terminating the meal, coaxing, or distracting are logical because they may produce the immediate effect of temporarily stopping the undesirable behavior (i.e., the parent's behavior may be maintained by negative reinforcement). However, from a functional perspective, such consequences can worsen mealtime problems over the long term if they function as reinforcement.

The purpose of the current study was to use functional analysis to assess the problem behavior of children with pediatric feeding disorders. The first goal of the study was to conduct naturalistic assessments to develop hypotheses about behavioral influences on mealtime behavior. The second goal was to use experimental functional analysis to evaluate the effects of each of the consequences used by the parents to determine if inappropriate behavior improved or worsened during meals.

METHOD

Participants

Six children (Allison, Craig, Todd, Robert, Tom, and Paul) and their parents participated in Study 1. Nine additional children participated in Study 2 (Maya, Nora, Peter, Sheila, Sally, Matt, Colin, Adam, and Kyle), for a total of 15 children in Study 2. The participants were patients in a pediatric feeding disorders program, and 1 child (Matt) was a patient on a neurobehavioral unit. The participants exhibited feeding problems that resulted in failure to thrive, inadequate nutritional status, or severe behavior problems at mealtimes that significantly interfered with food intake (participants' ages, sex, diagnoses, and specific problem behaviors are listed in Table 1).

Evaluation of Medical Status

The participants underwent a thorough interdisciplinary evaluation to assess underlying physical causes for the feeding problem. The medical team reviewed the participant's history and conducted indicated diagnostic studies. The team also assessed the safety of oral feeding by ensuring that the participant had the appropriate physiological status and skills to swallow and prevent aspiration of ingested foods. In addition, participants' nutritional and metabolic needs were evaluated to maintain or promote appropriate weight gain for age and size. When the interdisciplinary evaluation was completed, the team made recommendations regarding all aspects of the child's feeding problems that required treatment (e.g., pharmacological or surgical intervention, therapy to address oral motor issues, and nutritional support).

Setting and Materials

All analyses were conducted in rooms (3 m by 3 m) that were adjacent to rooms equipped with one-way observation and sound. Each child used age-appropriate seating arrangements (e.g., high chair, booster seat) and eating utensils. Children were served foods from the standard hospital trays for children who ate foods at a pureed texture or higher or a variety of jarred baby foods for children whose diet was limited to baby food. Food items were selected arbitrarily (i.e., we rotated through a variety of fruits, starches, vegetables, and meats) without consideration of the child's food preferences.

Response Measurement and Data Collection

Parent measures. During Study 1, data were collected on both parent and child behaviors. Parent behaviors included the delivery of escape, attention, and tangible items within 10 s of an inappropriate behavior. *Escape* was scored when the parent removed

Table 1
Participant Descriptions

Participant	Gender	Age (years– months)	Diagnoses	Inappropriate mealtime behaviors
Maya	F	1–9	Failure to thrive (FTT), food allergies	Batting, head turning, negative vocalizations
Nora	F	1–2	Gastroesophageal reflux (GER)	Batting, negative vocalizations
Peter	M	2–11	Cerebral palsy (CP), developmental delay (DD), FTT, bilateral hearing loss	Batting, head turning, negative vocalizations
Sheila	F	1–8	DD, FTT, GER	Batting, negative vocalizations
Allison	F	2–6	Delayed gastric emptying, GER, FTT, oral motor dysfunction	Batting, head turning, aggression, throwing food, covering face, negative vocalizations
Craig	M	6	DD, seizure disorder, GER, microcephaly, reactive airway disease, hypotonia, dysmorphism	Batting, head turning, negative vocalizations, aggression, self-injury, hand mouthing
Sally	F	1–6	CP, DD, GER	Batting, head turning, negative vocalizations
Matt	M	7	Autism, attention deficit hyperactivity disorder, severe mental retardation	Batting, aggression, throwing food
Todd	M	3	Spastic colon, chronic constipation, history of oral motor dysfunction	Batting, gagging, negative vocalizations
Colin	M	2–3	FTT, GER	Batting, head turning, negative vocalizations
Robert	M	4	CP, poor vision, autism	Batting, head turning, negative vocalizations
Tom	M	1–3	CP, DD, GER, oral motor dysfunction	Negative vocalizations
Paul	M	3	DD, right hemiplegia, cortical blindness, hydrocephalus, microcephaly	Batting, head turning, negative vocalizations
Kyle	M	2–2	FTT, brain cyst, cortical blindness, hypotonia, DD	Head turning, negative vocalizations
Adam	M	1–10	GER, FTT, reactive airway disease, asthma	Batting, head turning, negative vocalizations

the bite presentation or terminated the meal. *Attention* was scored when the parent delivered attention in the form of reprimands (“don’t do that”), verbal or physical redirection (“look at daddy, he’s eating his peas”), or coaxing (“you like green beans”). Delivery of a *tangible item* was scored when the parent gave the child a preferred food or a toy. Observers indicated the occurrence or non-occurrence of each type of parent response following the occurrence of each inappropriate child behavior. Data for parent responses were calculated by dividing the number of consequences following inappropriate behaviors by the number of inappropriate

behaviors multiplied by 100%. For example, if the child engaged in 10 inappropriate behaviors during the meal and the parent responded by providing attention following five of those behaviors, then the level of attention delivery was 50%. The number of meals observed varied for each participant (Allison, 3; Craig, 2; Todd, 2; Robert, 4; Tom, 1; Paul, 4).

Child measures. Data were collected on both appropriate and inappropriate mealtime behaviors for all children during Studies 1 and 2. The appropriate behavior was *acceptance* of food (the child accepting the bite or drink into his or her mouth within

5 s of the bite or drink presentation). Data also were collected for expelling food, gagging, and vomiting. *Inappropriate mealtime behaviors* differed for each child and are listed in Table 1; however, each child displayed at least one of the following inappropriate mealtime behaviors: head turning, batting at the spoon, throwing food or utensils, out of seat, negative vocalizations, self-injury, or aggression.

Expulsions were defined as emitting food or liquid larger than the size of a pea past the plane of the lips. *Gagging* was defined as retching via movement of stomach, chest and mouth, with or without audible noises. *Vomiting* was defined as emitting contents of the esophagus or stomach, consisting of previously digested food or liquid, past the plane of the lips. *Head turning* was defined as moving the head away from midline after spoon presentation. *Batting* at the spoon was defined as the child pushing the spoon or the therapist's hand away from his or her mouth. *Throwing food or utensils* was defined as the child throwing food or utensils across the room, at people, or onto the floor. *Out of seat* was defined as the child's bottom not touching the base of the chair for 3 s or more. *Negative vocalizations* were defined as screaming, crying, or making negative statements (e.g., "I don't want it," "no") above normal conversational levels that lasted for 3 s or more. *Self-injury* was defined as behavior directed towards the self that caused or had the potential to cause tissue damage (e.g., head banging, hand biting). *Aggression* was defined as behavior directed towards others that caused or had the potential to cause tissue damage (e.g., hitting, kicking, biting, scratching).

Data on child target responses were collected via event or frequency recording using a paper-and-pencil data-collection method. Acceptances, expulsions, gagging, vomiting, and inappropriate behaviors for Maya and Tom were collected via event recording (i.e.,

either the behavior occurred or did not occur during each bite presentation) and were recorded once for each bite presentation. Data for event-recording measures were converted to percentage of trials by dividing the number of occurrences of the behavior by the number of bite presentations multiplied by 100%. Inappropriate behaviors for all other participants were recorded as the frequency of occurrence. Data for inappropriate behaviors then were converted to a rate by dividing the total number of responses by the total number of minutes per session.

Interrater Agreement

Interrater agreement was obtained by having two observers record data simultaneously but independently on a mean of 47% and 32% of the sessions during Studies 1 and 2, respectively. Interrater agreement for appropriate and inappropriate behaviors recorded as event measures was calculated by dividing the number of agreements plus disagreements and multiplying by 100%. An agreement was defined as two observers agreeing that the behavior either occurred or did not occur, and a disagreement was defined as one observer scoring the occurrence of the behavior and one observer not scoring the occurrence of the behavior. For inappropriate behaviors recorded as frequency measures, the total number of inappropriate behaviors per bite presentation was compared by dividing the smaller frequency by the larger frequency and multiplying by 100%. The mean agreement coefficient for parent behaviors for all participants in Study 1 was 97% (range, 92% to 100%). The mean agreement coefficient for inappropriate child behaviors for all participants was 95% (range, 87% to 100%) during Study 1 and 92% (range, 76% to 100%) during Study 2. The mean agreement coefficient for acceptances was 98% (range, 91% to 100%) during Study 2.

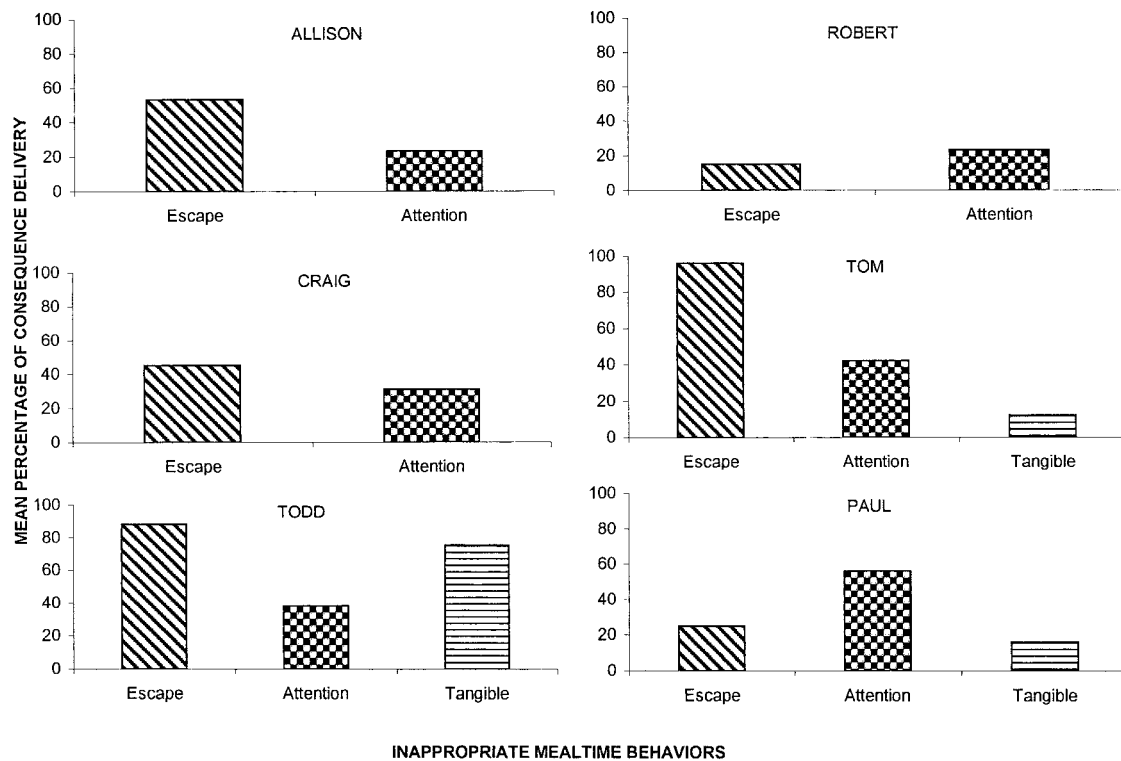


Figure 1. Mean percentage of consequence delivery for Allison, Craig, Todd, Robert, Tom, and Paul.

STUDY 1: OBSERVATIONS OF MEALS FED BY PARENTS

Procedure

Parents were observed feeding their children in rooms at the program site. They were asked to feed the child as they normally would at home and to use similar materials (e.g., foods, utensils, toys). They also were asked to respond to the child's behaviors as they typically did at home. Prior to these observations, we asked parents to describe the procedures they used at home during meals. Specific tangible items were available in the room if the parents reported providing such items to the child during meals. Meals varied in length and ended when the parent terminated the meal (i.e., as they would do at home).

Results

The results of Study 1 are depicted in Figure 1. Each parent used a variety of conse-

quences during meals. All parents provided attention in the form of reprimands (e.g., "don't throw food"), soothing comments (e.g., "it's okay, don't cry"), or coaxing (e.g., "you like this") when their children displayed inappropriate behavior. All parents removed bites of food (allowed the child to take a break or escape eating) following inappropriate behavior. Three of the 6 parents gave their child a tangible item (i.e., a preferred food, drink, toys) when the child engaged in inappropriate behavior.

STUDY 2: FUNCTIONAL ANALYSIS

The results of Study 1 suggested that parents used a variety of potentially functional consequences when their child engaged in inappropriate behavior during mealtime. Because the consequences differed from parent to parent and because all parents used more than one consequence when their child engaged in inappropriate behavior, it was not

possible to determine the effects of any one consequence on inappropriate behavior in Study 1. Therefore, the individual effects of each consequence (escape, tangible, attention) on inappropriate behavior were evaluated systematically in Study 2.

General Procedure

Each session was 10 min long, and bites of food were presented once every 30 s. During each presentation, a spoon was held 2.5 cm from the child's lips and the child was instructed to "take a bite." Trained therapists fed all meals. One food item from each of four food groups (protein, starch, fruit, vegetable) was offered during each session, and bite presentations rotated randomly among the four food groups. Selection of food texture and bite size was based on the child's skills, previous experiences with eating, and the recommendations of the occupational therapist. Three to four session blocks were conducted each day, with two to three 10-min functional analysis sessions (20 to 30 min of total eating time) per session block (for a total of 6 to 12 sessions per day). Brief breaks (5 to 10 min) were provided between each session, during which the child was allowed to leave the therapy room and play. Session blocks were spaced approximately 2 to 3 hr apart (e.g., 8:30 a.m., 11:30 a.m., 2:00 p.m., 4:00 p.m.). Acceptance of bites of food resulted in brief praise (e.g., "good eating") across all experimental and baseline conditions and presentation of another bite of food at the next 30-s interval. Inappropriate behaviors resulted in one of three types of consequences (negative reinforcement, positive reinforcement in the form of attention, or positive reinforcement in the form of tangible items), depending on the condition in effect.

Specific Procedure

Baseline (play). Toys were available on the tray of the high chair or the table, and the

therapist interacted (e.g., engaged in conversation) with the child throughout the session. If the child engaged in inappropriate behavior, the therapist did not provide a differential consequence (i.e., the therapist continued interacting with the child as if the behavior did not occur). The spoon remained 2.5 cm from the child's lips following inappropriate behavior and for the duration of the 30-s interval. At the end of the 30-s interval, the therapist removed the spoon and presented a new bite of food to the child. The purpose of this condition was to observe the frequency of inappropriate behavior when the child had free access to attention and preferred items. Low levels of inappropriate behavior in this condition would indicate that the child was not motivated to engage in inappropriate behavior when preferred interaction and items were available continuously.

Escape. If the child engaged in an inappropriate behavior, the therapist removed the spoon of food for the remainder of the 30-s interval. Another bite of food was presented at the next 30-s interval. The therapist did not provide any other differential consequence following the child's inappropriate behavior (e.g., the therapist did not reprimand the child). Toys were not available during these sessions. The purpose of this condition was to simulate a situation in which a parent removed the bite (i.e., allowed escape) when the child engaged in inappropriate behavior. High levels of inappropriate behavior in this condition would suggest that the child's behavior was sensitive to escape as reinforcement.

Attention. Inappropriate behavior resulted in brief (5 to 10 s) attention, in the form of coaxing (e.g., "you like this") and statements of concern (e.g., "don't cry, you'll be okay"). The spoon remained 2.5 cm from the child's lips following inappropriate behavior and for the duration of the 30-s interval. At the end of the 30-s interval, the therapist removed

the spoon and presented a new bite of food to the child. Toys were not available during these sessions. The purpose of this condition was to simulate a situation in which the parent provided attention or coaxing to motivate the child to eat. High levels of inappropriate behavior in this condition would suggest that the child's behavior was sensitive to positive reinforcement in the form of attention.

Tangible. Inappropriate behavior resulted in the presentation of a tangible item (preferred toys, foods, or drinks) for the remainder of the 30-s interval. The therapist placed preferred toys or edible items on the tray and allowed the child to interact with the toys or consume the edible items. However, the spoon with the original bite of food remained 2.5 cm from the child's lips following inappropriate behavior and for the duration of the 30-s interval. The therapist did not provide any other differential consequence following inappropriate behavior and did not interact with the child if the child had a toy. At the end of the 30-s interval, the therapist removed the spoon and the tangible item and presented a new bite of food. The tangible items were selected based on direct observations and parent report of the items they presented to their child when the child did not eat. Tangible items for individual children included chocolate ice cream, bacon, toys, milk, and television. The purpose of this condition was to simulate a situation in which parents attempted to motivate their child to eat by providing them with preferred items, activities, or food. High levels of inappropriate behavior in this condition would suggest that the child's behavior was sensitive to positive reinforcement in the form of the tangible item.

Design and Independent Variables

We used a reversal design in which each test condition was compared to the baseline (play) condition. All analyses began with the

baseline condition. The order of test conditions was selected randomly. The test conditions with the highest rates of inappropriate mealtime behaviors were repeated to establish experimental control.

RESULTS

The means and standard deviations of measures of inappropriate behaviors for the four conditions across all participants were attention ($M = 5.04$, $SD = 4.7$), escape ($M = 3.14$, $SD = 1.47$), tangible ($M = 5.42$, $SD = 4.7$), and play ($M = 0.7$, $SD = 0.52$). The results of the functional analyses appear in Figure 2 for Maya and Nora; in Figure 3 for Peter, Sheila, and Allison; in Figure 4 for Craig, Sally, and Matt; in Figure 5 for Todd, Colin, and Robert; and in Figure 6 for Tom. Three participants (data not shown) displayed low to zero rates of inappropriate behaviors across all conditions.

Ten (Maya, Nora, Peter, Sheila, Allison, Craig, Sally, Matt, Todd, and Tom) of the 15 participants (67%) displayed high levels of inappropriate behavior during one or more of the test conditions relative to the baseline condition, suggesting that environmental variables played a role in the child's feeding problem. Inappropriate behavior was high in the escape condition for 9 (60%) of the participants (Maya, Nora, Peter, Sheila, Allison, Craig, Sally, Todd, and Tom). Inappropriate behavior was high in the attention condition for 8 (53%) of the participants (Maya, Peter, Sheila, Allison, Craig, Sally, Matt, and Tom) and high in the tangible condition for 2 participants (Todd and Tom).

Tom (Figure 6) displayed two types of behaviors, inappropriate mealtime behavior (top panel) and expulsion (bottom panel). Expulsions occurred across all conditions, whereas inappropriate mealtime behavior occurred at higher levels during the test conditions (demand, attention, and tangible). These results suggested that Tom's inappro-

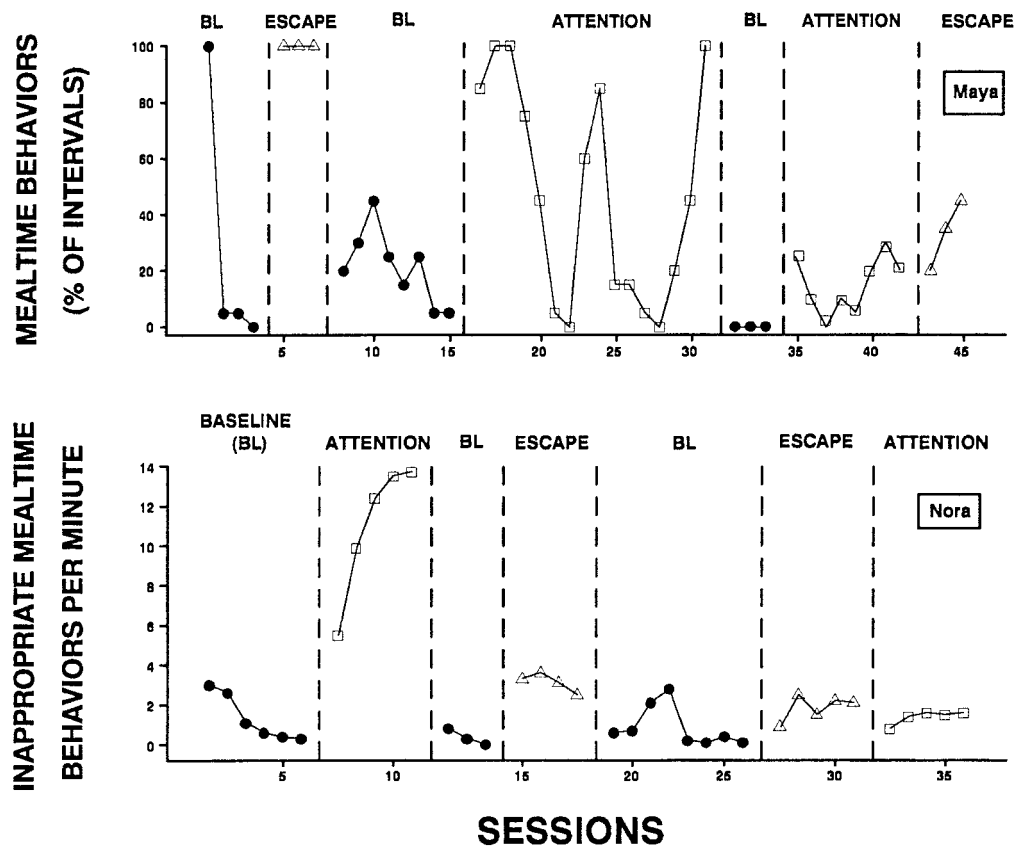


Figure 2. Percentage of intervals of inappropriate mealtime behaviors for Maya and inappropriate mealtime behaviors per minute for Nora.

priate mealtime behaviors were influenced by environmental factors (i.e., attention, escape, and access to tangible items), whereas his expulsion of food was not.

Table 2 depicts the results of the naturalistic observations (the consequences that the parents used following inappropriate mealtime behavior), the analogue functional analysis (the reinforcers that maintained inappropriate mealtime behavior), and the treatment outcomes based on percentages of acceptance in baseline and the treatment in use at discharge. The results of the naturalistic observations and the analogue functional analyses yielded identical results for 3 of the 6 participants (Allison, Craig, and Tom). Todd's parents provided escape, attention, and tangible items. However, the results of

his analogue functional analysis suggested that his inappropriate behavior was sensitive to negative reinforcement (escape) and positive reinforcement (tangible items), but not attention. Robert's parents provided escape and attention following inappropriate mealtime behaviors; however, Robert's analogue functional analysis was undifferentiated (i.e., his inappropriate behavior was not differentially sensitive to escape or attention as reinforcement). Paul's parents provided escape, attention, and a tangible item following inappropriate mealtime behaviors; however, Paul (data not shown) did not exhibit inappropriate behavior in the analogue functional analysis (i.e., his inappropriate behavior was not differentially sensitive to escape, attention, or tangible items as reinforce-

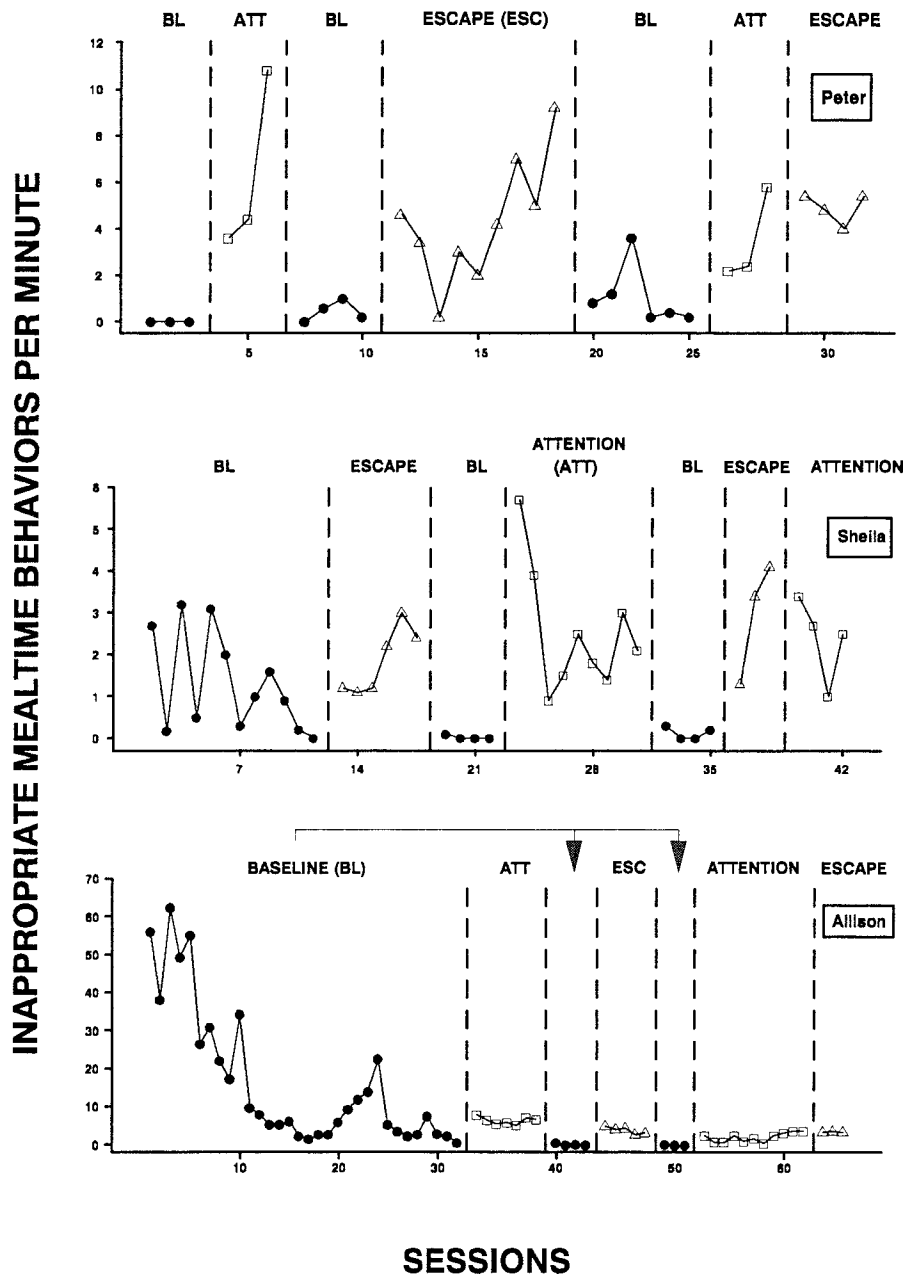


Figure 3. Inappropriate mealtime behaviors per minute for Peter, Sheila, and Allison.

ment). Treatment resulted in increases in acceptance above 80% for all participants.

We also evaluated the extent to which the recommended treatments matched the results of the functional analysis. Positive reinforcement in the form of attention and ex-

inction for attention (ignoring) were used in treatment for 88% and 100%, respectively, of participants who demonstrated sensitivity to attention as reinforcement. Negative reinforcement in the form of escape and escape extinction (either nonremoval of the

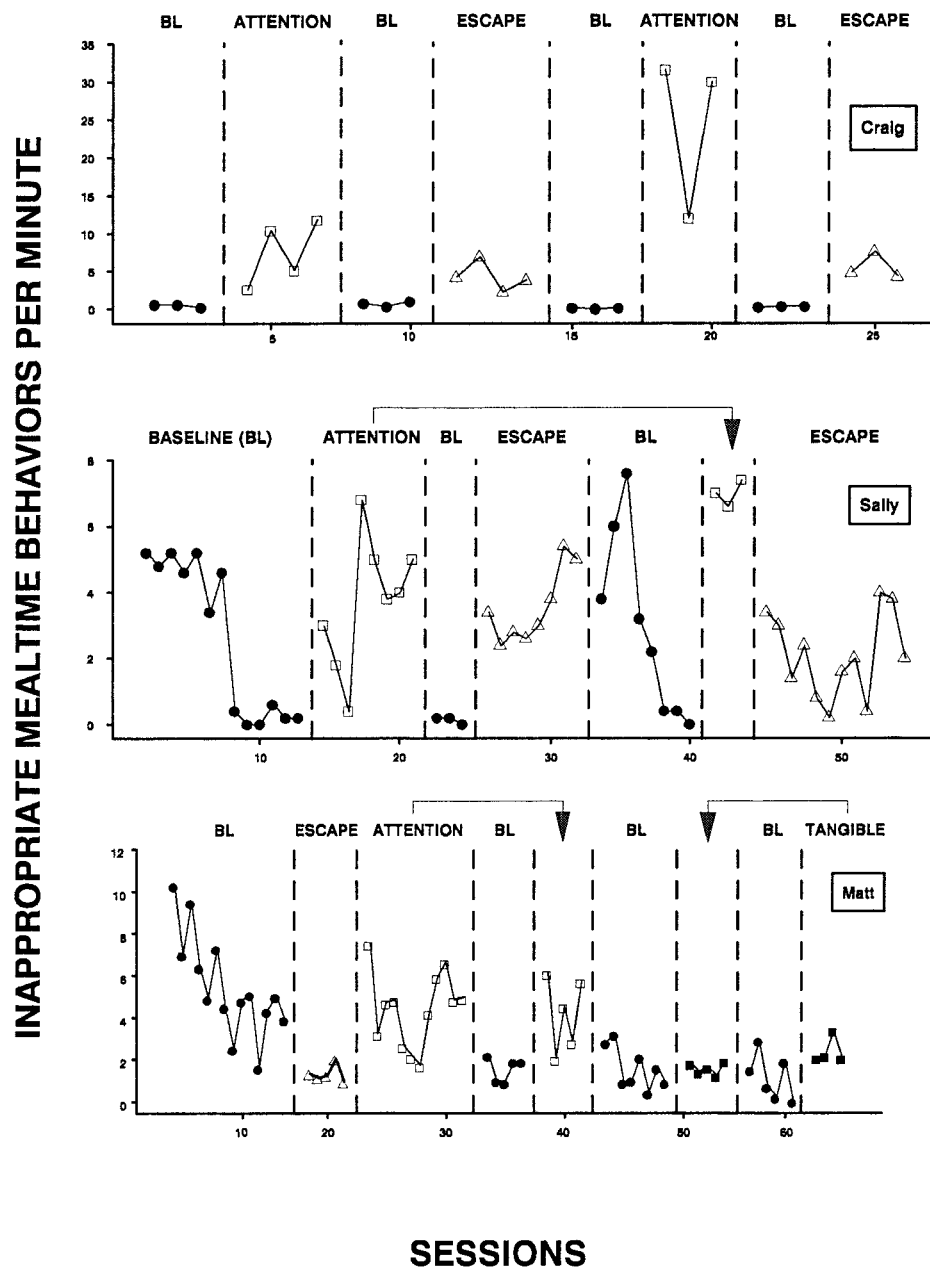


Figure 4. Inappropriate mealtime behaviors per minute for Craig, Sally, and Matt.

spoon or physical guidance) was used for 11% and 67%, respectively, of participants who demonstrated sensitivity to escape as reinforcement. Positive reinforcement in the form of tangible items and extinction for behaviors maintained by tangible items were used in treatment for 100% of participants

who demonstrated sensitivity to tangible items as reinforcement.

DISCUSSION

The results of the current investigation suggested that environmental variables play

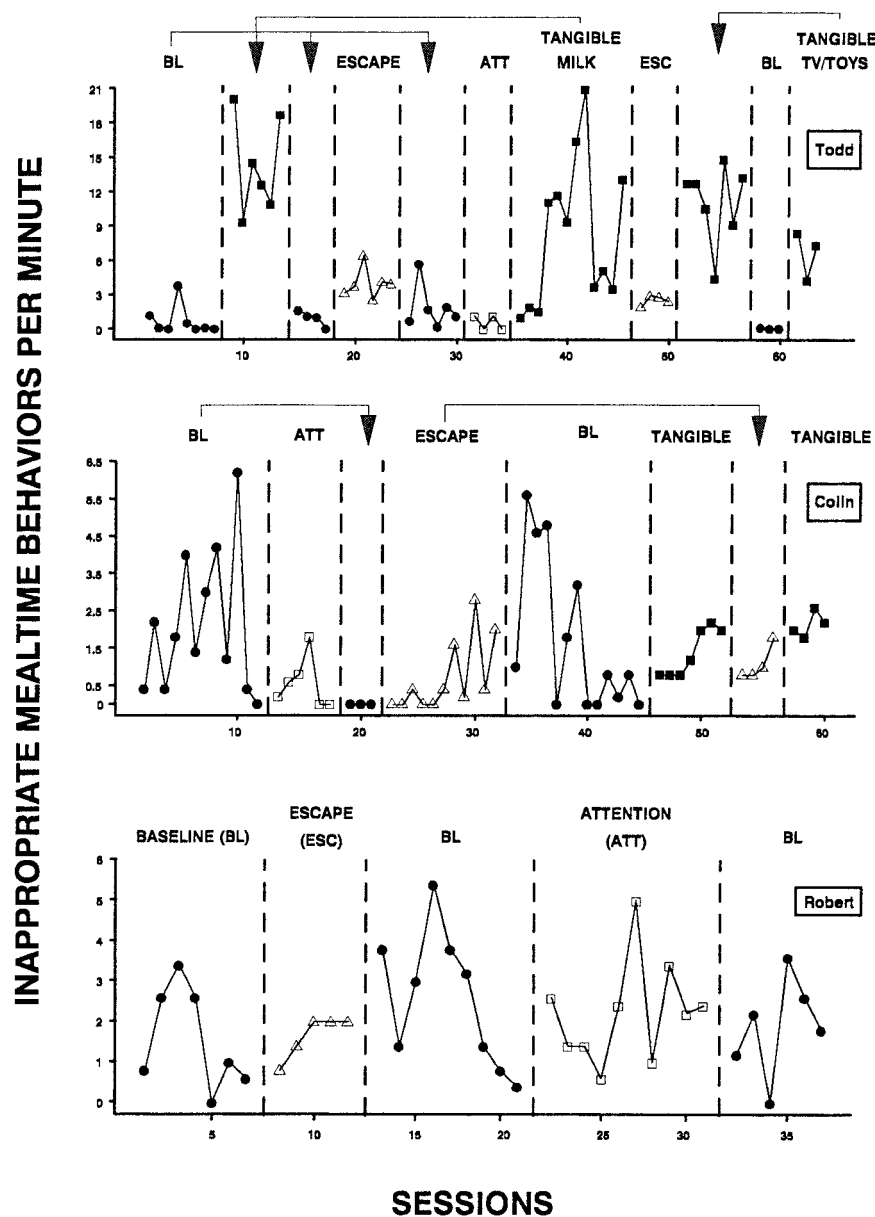


Figure 5. Inappropriate mealtime behaviors per minute for Todd, Colin, and Robert.

a role in the occurrence of feeding disorders. The results of Study 1 showed that parents provided a variety of consequences when their children engaged in inappropriate behavior that may be functionally related to that behavior. In the natural environment, it would be very difficult (if not impossible) to evaluate which combination of consequences

(if any) affect behavior (Lerman & Iwata, 1993). Therefore, the functional analysis conducted in Study 2 tested the extent to which each of the consequences functioned as reinforcement for inappropriate behavior for individual children. These data suggested that functional analysis could be used to identify the reinforcers for feeding problems.

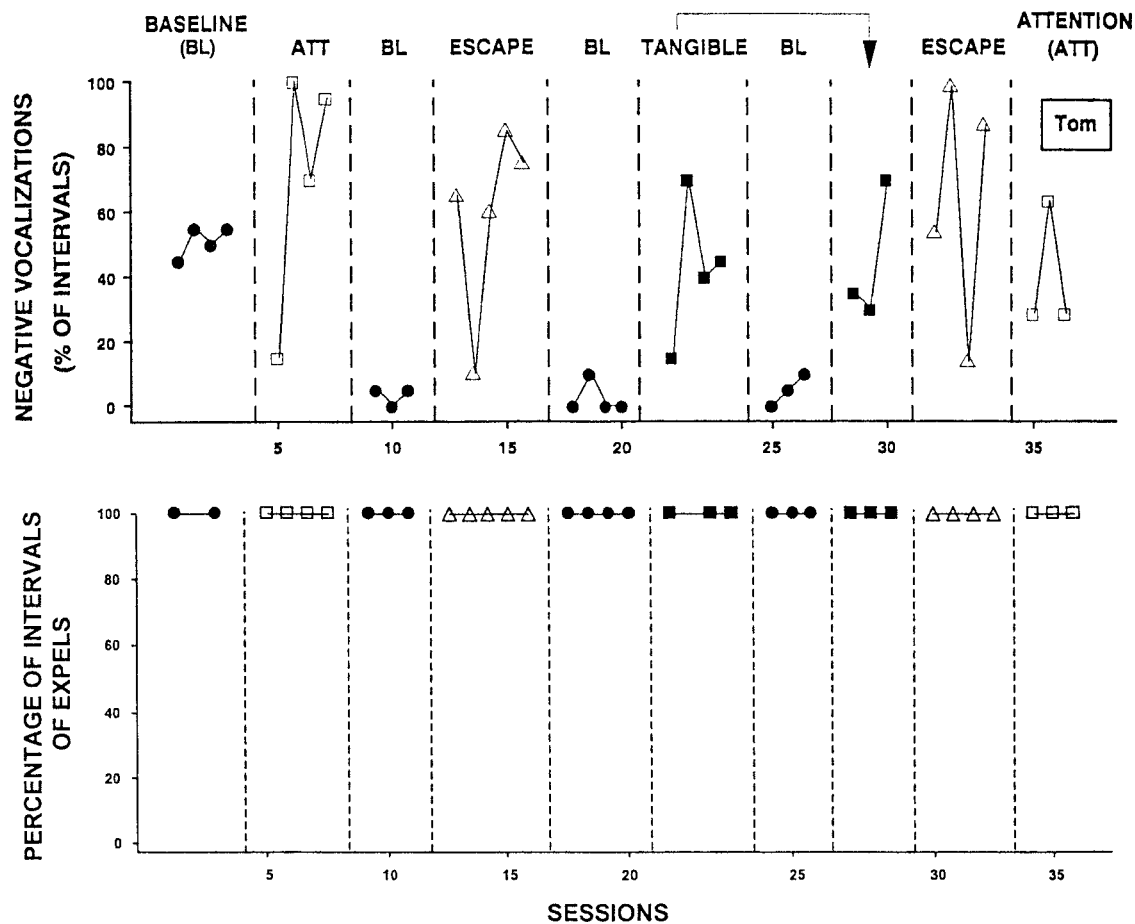


Figure 6. Percentage of intervals of negative vocalizations (top panel) and expulsions (bottom panel) for Tom.

One important contribution of functional analysis is that it has provided behavior analysts with a tool with which to improve our understanding of the influences of operant mechanisms on behavior disorders (Fisher, DeLeon, & Kuhn, 2000). For example, Carr's (1977) hypotheses that self-injurious behavior could be reinforced by positive reinforcement (attention), negative reinforcement (escape from tasks), or by the sensory consequences automatically produced by the response largely have been validated through epidemiological investigations using functional analysis (Derby et al., 1992; Iwata, Pace, Dorsey, et al., 1994). Similarly, the current results provide partial support for

the hypothesis proposed by a number of investigators that feeding problems are maintained by negative reinforcement (Ahearn et al., 1996; Cooper et al., 1999; Hoch et al., 1994; Patel et al., 2002). Specifically, of the 10 children who demonstrated sensitivity to one or more of the reinforcers tested during the functional analysis, 90% demonstrated sensitivity to escape as reinforcement, suggesting that negative reinforcement contributes to the maintenance of feeding problems for many children.

Although the current results document the role of negative reinforcement in the maintenance of feeding problems, perhaps the more surprising and interesting finding

Table 2
Results from Naturalistic Observation, Analogue Functional Analysis, and Treatment

Participant	Naturalistic observations	Functional analysis	% Acceptance	
			Baseline	Treatment
Maya		Escape and attention	18	100
Nora		Escape	0	99
Peter		Escape and attention	60	92
Sheila		Escape and attention	0	100
Allison	Escape and attention	Escape and attention	0	99
Craig	Escape and attention	Escape and attention	6	95
Sally		Escape and attention	0	96
Matt		Attention	40	87
Todd	Escape, attention, and tangible	Escape and tangible	10	97 ^a
Colin		No differentiation	49	99
Robert	Escape and attention	No differentiation	38	96
Tom	Escape, attention, and tangible	Escape, attention, and tangible	81	99
Paul	Escape, attention, and tangible	No behaviors	81	— ^b

^a Data for Todd reflect the percentage of bites he consumed (number of bites swallowed divided by number of bites presented).

^b No programmed treatment was implemented for Paul because he consumed food in baseline.

was that positive reinforcement contributed to the maintenance of inappropriate mealtime behavior in over half the cases. In addition, tangible items functioned as reinforcement for 13% of the children. The results of the naturalistic observations suggested that parents provide attention (in the form of coaxing) or tangible items (in the form of toys or preferred foods) following inappropriate mealtime behavior. The results of the experimental functional analysis suggested that for some children, these consequences function as reinforcement for inappropriate behavior.

A second important contribution of functional analysis has been to provide assessment data that categorize aberrant behavior according to its functional rather than its topographical properties. Previous studies have shown that topographically dissimilar responses can be members of a common functional response class (e.g., Lalli, Mace, Wohn, & Livezey, 1995) and that the same topographical response (e.g., aggression) can belong to multiple functional response classes (e.g., Thompson et al., 1998). The current results suggest that inappropriate meal-

time behavior may similarly be multiply controlled. In addition, functional analysis results may help to distinguish between behaviors associated with a lack of motivation to eat versus other factors (e.g., skill deficits). For example, Tom displayed two types of problems during meals, expulsions and inappropriate behavior. Expulsions occurred across all conditions, whereas inappropriate behavior occurred at higher levels when these behaviors produced attention, toys, or escape from the bite. Thus, the results from Tom's analysis suggested that his inappropriate behavior was influenced by the tested environmental factors (i.e., attention, escape, and access to tangible items), whereas his expulsion of food was not.

A third important contribution of functional analysis has been the development of highly specific and effective interventions that directly address the function or functions that maintain the problem behavior (e.g., Iwata, Pace, Cowdery, & Miltenberger, 1994). For example, escape extinction would be an indicated treatment and time-out would be contraindicated for inappropriate mealtime behavior maintained by negative

reinforcement. By contrast, time-out could be an appropriate treatment for children who engage in inappropriate behavior that is functionally related to attention. Treatments also may be developed that target both motivational and skill deficits. For example, Tom's treatment consisted of a function-based component (noncontingent reinforcement with attention and toys) and a component to address his oral motor deficits (recommended by the occupational therapist) to facilitate swallowing.

Overall, a function-based treatment was developed for 8 of the 10 participants whose functional analysis results were differentiated. At least one of the functional reinforcers (escape, attention, tangible items) was used in a reinforcement-based treatment (i.e., either differential positive, differential negative, or noncontingent reinforcement) for 100% of the participants. An escape extinction procedure was used with 6 of the 9 (67%) participants for whom escape was identified as a reinforcer for inappropriate mealtime behavior. Inappropriate behavior was ignored for 100% of participants who demonstrated sensitivity to attention as reinforcement. All of the participants who received function-based treatments met their treatment goals for oral intake. However, the unique contribution of the functional analysis results could not be isolated in most cases because a multicomponent treatment approach was implemented (e.g., differential reinforcement plus escape extinction).

Although the results of the current investigation suggested that functional analysis has a number of advantages for understanding, assessing, and treating feeding problems, the study also has a number of limitations, which may have implications for functional analysis of feeding problems. One limitation was that the functional analyses conducted in the current investigation were somewhat artificial because (a) the events that occurred during the meal sessions were controlled

carefully, (b) the meals were conducted by trained therapists rather than parents, and (c) the meals were conducted in a therapy room rather than at home or in other natural settings. In addition, the analyses used here were carried out with children who were referred to an intensive, hospital-based program for the assessment and treatment of feeding disorders. Thus, our results may not be representative of a broader sample of children with feeding disorders. However, the results suggest that under controlled conditions, the effects of environmental events on feeding problems can be assessed using functional analysis.

In summary, the literature on functional analysis unambiguously demonstrates that it is a powerful technology that can identify environmental influences on a broad range of problem behaviors. In the current study, the range of functional analysis was extended to potentially life-threatening problems such as food refusal and failure to thrive. Despite the limitations of our study, the extent and seriousness of these feeding problems, the limitations of organismic accounts (e.g., medical, skill deficits), the clear results we obtained provide a strong rationale for continuing investigations of this sort.

The results raise a number of important questions about the use of functional analysis in the assessment and treatment of pediatric feeding problems that should be the focus of future investigations. First, the results of the current study suggest that parents use a variety of consequences when their children exhibit feeding problems. Future research should focus on observing children at risk for the development of feeding problems to understand how parental responses to child behavior at meals affect the development of feeding problems. Second, the results of the current investigation suggest that negative reinforcement plays a significant role in the maintenance of feeding problems. Therefore, future studies should focus on

understanding the role of escape extinction in the treatment of feeding problems. For example, under what conditions is escape extinction effective in treatment, and do differential or noncontingent reinforcement procedures contribute to treatment effects? Several procedures have been conceptualized as escape extinction (Ahearn *et al.*, 1996; Coe *et al.*, 1997; Cooper *et al.*, 1999), but it is not clear which procedures constitute escape extinction for individual children.

Also, as indicated by the literature on feeding problems taken as a whole, there is a continuum of seriousness. The problems addressed here were on the high end, as indicated by the intensiveness of the treatment sought by parents (e.g., hospital admission). Whether functional analysis would be as useful with problems on the lower end of the continuum (e.g., picky eating) is unknown, yet the literature on functional analysis suggests that it might be. At first, functional analysis was used with life-threatening behavior problems (e.g., SIB; Iwata *et al.*, 1982/1994). After successes with these problems were reported, functional analysis technology was applied with less intense problems (e.g., noncompliance; Northup *et al.*, 1994) and similar levels of success were reported. Thus it seems plausible that use of functional analysis with a broader range of feeding problems, beginning with serious problems as in this study and migrating to less serious problems in studies to come, would follow a similar trajectory of success. In conclusion, our results underscore and add to the importance of the role functional analysis can play in the assessment of problematic behavior, and they supply support for expanding investigations into a new realm, feeding problems.

REFERENCES

- Ahearn, W. H., Kerwin, M. E., Eicher, P. S., Shantz, J., & Swearingin, W. (1996). An alternating treatments comparison of two intensive interventions for food refusal. *Journal of Applied Behavior Analysis*, 29, 321–332.
- Babbitt, R. L., Hoch, T. A., & Coe, D. A. (1994). Behavioral feeding disorders. In D. Tuchman & R. Walters (Eds.), *Pediatric feeding and swallowing disorders: Pathology, diagnosis, and treatment*. San Diego, CA: Singular Publishing Group.
- Budd, K. S., McGraw, T. E., Farbisz, R., Murphy, T. B., Hawkins, D., Heilman, N., *et al.* (1992). Psychosocial concomitants of children's feeding disorders. *Journal of Pediatric Psychology*, 17, 81–94.
- Carr, T. E. (1977). The motivation of self-injurious behavior: A review of some hypotheses. *Psychological Bulletin*, 84, 800–816.
- Coe, D. A., Babbitt, R. L., Williams, K. E., Hajimihalis, C., Snyder, A. M., Ballard, C., *et al.* (1997). Use of extinction and reinforcement to increase food consumption and reduce expulsion. *Journal of Applied Behavior Analysis*, 30, 581–583.
- Cooper, L. J., Wacker, D. P., Brown, K., McComas, J. J., Peck, S. M., Drew, J., *et al.* (1999). Use of a concurrent operants paradigm to evaluate positive reinforcers during treatment of food refusal. *Behavior Modification*, 23, 3–40.
- Derby, K. M., Wacker, D. P., Sasso, G., Steege, M., Northup, J., Cigrand, K., *et al.* (1992). Brief functional assessment techniques to evaluate aberrant behavior in an outpatient setting: A summary of 79 cases. *Journal of Applied Behavior Analysis*, 25, 713–721.
- Fisher, W. W., DeLeon, I. G., & Kuhn, D. E. (2000). Functional analysis of precurrent contingencies between mands and destructive behavior. In J. C. Leslie & D. Blackman (Eds.), *Issues in the experimental and applied analyses of human behavior* (pp. 212–234). Reno, NV: Context Press.
- Fisher, W. W., Piazza, C. C., & Page, T. (1989). Assessing independent and interactional effects of behavioral and pharmacologic interventions for a client with dual diagnoses. *Journal of Behavior Therapy and Experimental Psychiatry*, 20, 241–250.
- Hoch, T. A., Babbitt, R. L., Coe, D. A., Krell, D. M., & Hackbert, L. (1994). Contingency contacting: Combining positive reinforcement and escape extinction procedures to treat persistent food refusal. *Behavior Modification*, 18, 106–128.
- Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*, 27, 197–209. (Reprinted from *Analysis and Intervention in Developmental Disabilities*, 2, 3–20, 1982)
- Iwata, B. A., Pace, G. M., Cowdery, G. E., & Miltenberger, R. G. (1994). What makes extinction work: An analysis of procedural form and function. *Journal of Applied Behavior Analysis*, 27, 131–144.

- Iwata, B. A., Pace, G. M., Dorsey, M. F., Zarcone, J. R., Vollmer, T. R., Smith, R. G., et al. (1994). The functions of self-injurious behavior: An experimental-epidemiological analysis. *Journal of Applied Behavior Analysis*, 27, 215–240.
- Kelley, M. E., Piazza, C. C., Fisher, W. W., & Oberdorff, A. J. (2003). Acquisition of cup drinking using previously refused foods as positive and negative reinforcement. *Journal of Applied Behavior Analysis*, 36, 89–93.
- Lalli, J. S., Mace, F. C., Wohn, T., & Livezey, K. (1995). Identification and modification of a response-class hierarchy. *Journal of Applied Behavior Analysis*, 28, 551–559.
- Lerman, D. C., & Iwata, B. A. (1993). Descriptive and experimental analyses of variables maintaining self-injurious behavior. *Journal of Applied Behavior Analysis*, 26, 293–319.
- Mace, F. C., & Lalli, J. S. (1991). Linking descriptive and experimental analyses in the treatment of bizarre speech. *Journal of Applied Behavior Analysis*, 24, 553–562.
- Northup, J., Wacker, D. P., Berg, W. K., Kelly, L., Sasso, G., & DeRaad, A. (1994). The treatment of severe behavior problems in school settings using a technical assistance model. *Journal of Applied Behavior Analysis*, 27, 33–47.
- Patel, M. R., Piazza, C. C., Kelly, M. L., Ochsner, C. A., & Santana, C. M. (2001). Using a fading procedure to increase fluid consumption in a child with feeding problems. *Journal of Applied Behavior Analysis*, 34, 357–360.
- Patel, M. R., Piazza, C. C., Martinez, C. J., Volkert, V. M., & Santana, C. M. (2002). An evaluation of two differential reinforcement procedures with escape extinction to treat food refusal. *Journal of Applied Behavior Analysis*, 35, 183–186.
- Patel, M. R., Piazza, C. C., Santana, C. M., & Volkert, V. M. (2002). An evaluation of food type and texture in the treatment of a feeding problem. *Journal of Applied Behavior Analysis*, 35, 363–374.
- Piazza, C. C., Hanley, G. P., Bowman, L. B., Ruyter, J. M., Lindauer, S. E., & Saiontz, D. M. (1997). Functional analysis and treatment of elopement. *Journal of Applied Behavior Analysis*, 30, 653–672.
- Piazza, C. C., Hanley, G. P., & Fisher, W. W. (1996). Functional analysis and treatment of cigarette pica. *Journal of Applied Behavior Analysis*, 29, 437–450.
- Piazza, C. C., Patel, M. R., Santana, C. M., Goh, H., Delia, M. D., & Lancaster, B. M. (in press). An evaluation of simultaneous and sequential presentation of preferred and nonpreferred food to treat food selectivity. *Journal of Applied Behavior Analysis*.
- Polan, H. J., Kaplan, M. D., Kessler, D. B., Shindledecker, R., Newmark, M., Stern, D. N., et al. (1991). Psychopathology in mothers of children with failure to thrive. *Infant Mental Health Journal*, 12, 55–64.
- Riordan, M. M., Iwata, B. A., Finney, J. W., Wohl, M. K., & Stanley, A. E. (1984). Behavioral assessment and treatment of chronic food refusal in handicapped children. *Journal of Applied Behavior Analysis*, 17, 327–341.
- Riordan, M. M., Iwata, B. A., Wohl, M. K., & Finney, J. W. (1980). Behavioral treatment of food refusal and selectivity in developmentally disabled children. *Applied Research in Mental Retardation*, 1, 95–112.
- Thompson, R. H., Fisher, W. W., Piazza, C. C., & Kuhn, D. E. (1998). The evaluation of aggression maintained by attention and automatic reinforcement. *Journal of Applied Behavior Analysis*, 31, 103–116.
- Vollmer, T. R., Northup, J., Ringdahl, J. E., LeBlanc, L. A., & Chauvin, T. M. (1996). Functional analysis of severe tantrums displayed by children with language delays: An outclinic assessment. *Behavior Modification*, 20, 97–115.

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STUDY QUESTIONS

1. Why might it be helpful to conduct a functional analysis of children's inappropriate mealtime behavior?
2. Briefly describe the two categories of dependent variables measured in Study 1.
3. What establishing operations and consequences were manipulated in each of the functional analysis conditions?

4. In Study 2, what might have accounted for the gradual decreases in inappropriate behaviors observed during baseline for 8 of the 12 participants?
5. Briefly summarize the results of Study 2. Provide an alternative explanation for the high rates of inappropriate behavior observed during both the attention and tangible conditions.
6. Results of the naturalistic observations (Study 1) revealed that parents provided a variety of consequences for problem behavior observed during feeding situations. Why was it important to conduct subsequent functional analyses?
7. How might one determine whether inappropriate behaviors that were high in both the escape and attention conditions during Study 2 were actually multiply maintained?
8. Describe several ways in which the results of this study contribute to the literature on the assessment and treatment of feeding problems.

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